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Cowger et al.

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(54) **PRINTHEAD ASSEMBLY**

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(Continued)

(58) **Field of Classification Search**
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See application file for complete search history.

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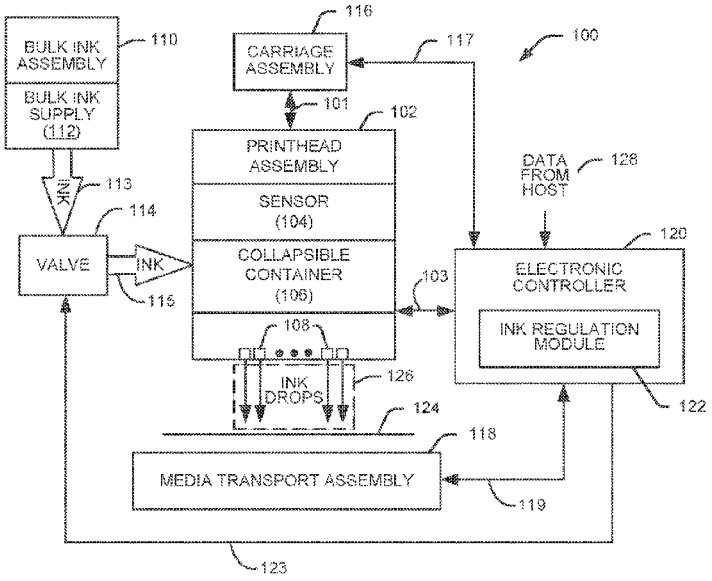
(57) **ABSTRACT**

One example of a system includes a bulk ink assembly, a printhead assembly, a valve, and a controller. The bulk ink assembly receives a bulk ink supply. The printhead assembly includes nozzles to eject ink drops, a collapsible container to supply ink to the nozzles, and a sensor to provide a sensor signal indicating the amount of ink within the collapsible container. The valve supplies ink to the collapsible container from the bulk ink assembly in response to a control signal. The controller provides the control signal based on the sensor signal to regulate the amount of ink in the collapsible container and to provide an out of ink signal based on the sensor signal indicating the bulk ink supply is effectively empty.

20 Claims, 6 Drawing Sheets



(52) **U.S. Cl.**
CPC .. ***B41J 2/17596*** (2013.01); *B41J 2002/17516* (2013.01); *B41J 2002/17579* (2013.01); *B41J 2002/17586* (2013.01)

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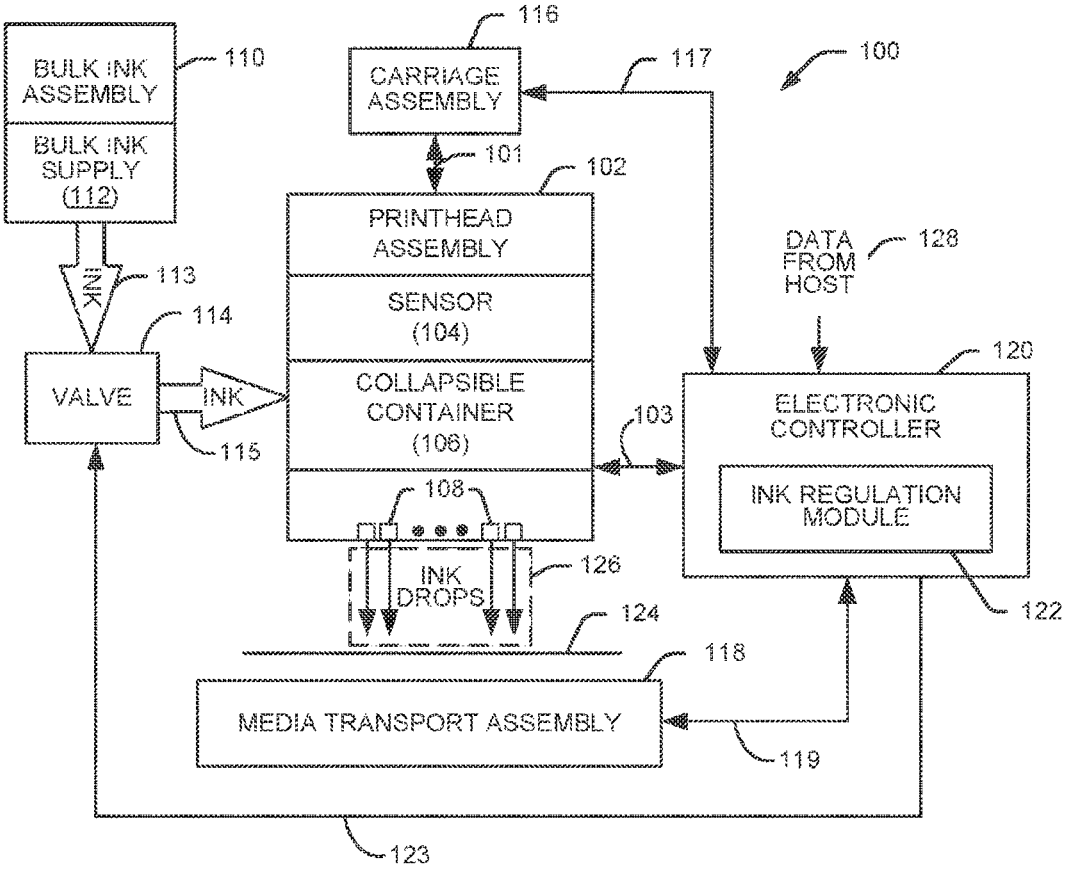
BULK INK ASSEMBLY
110
BULK INK SUPPLY (112)
INK
113
VALVE
114
INK
115
116
CARRIAGE ASSEMBLY
117
100
101
102
PRINTHEAD ASSEMBLY
SENSOR (104)
COLLAPSIBLE CONTAINER (106)
108
INK DROPS
126
124
118
MEDIA TRANSPORT ASSEMBLY
119
123
DATA FROM HOST
128
120
ELECTRONIC CONTROLLER
INK REGULATION MODULE
122
103

Fig. 1

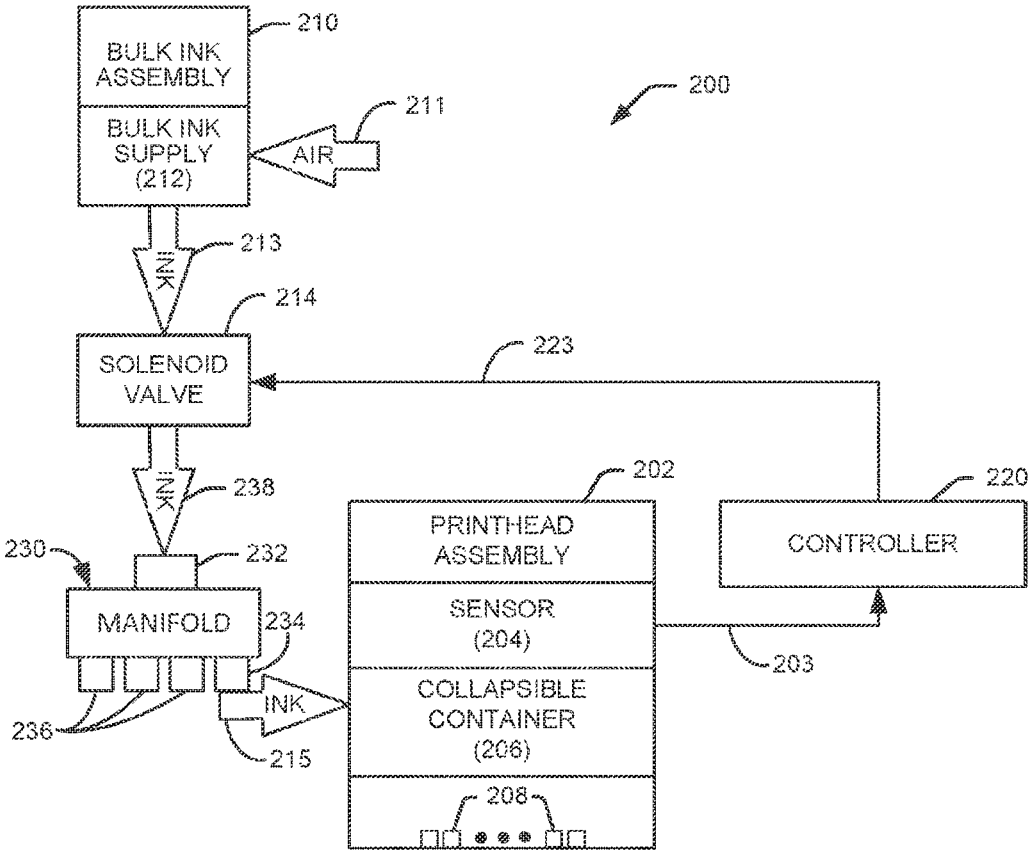
BULK INK ASSEMBLY
210
BULK INK SUPPLY (212)
211
AIR
200
INK
213
214
SOLENOID VALVE
223
INK
238
202
PRINTHEAD ASSEMBLY
220
CONTROLLER
230
232
MANIFOLD
234
SENSOR (204)
203
INK
COLLAPSIBLE CONTAINER (206)
236
215
208

Fig. 2

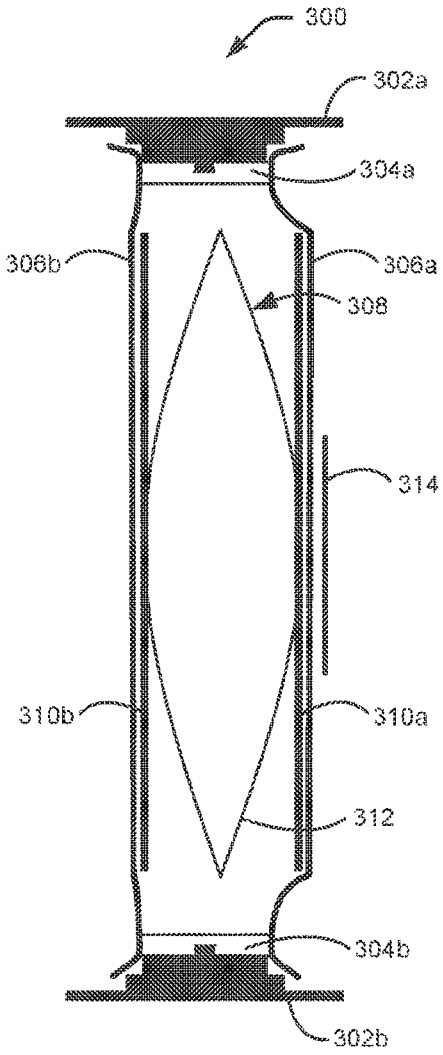
300
302a
304a
306b
306a
308
314
310b
310a
312
304b
302b

Fig. 3A

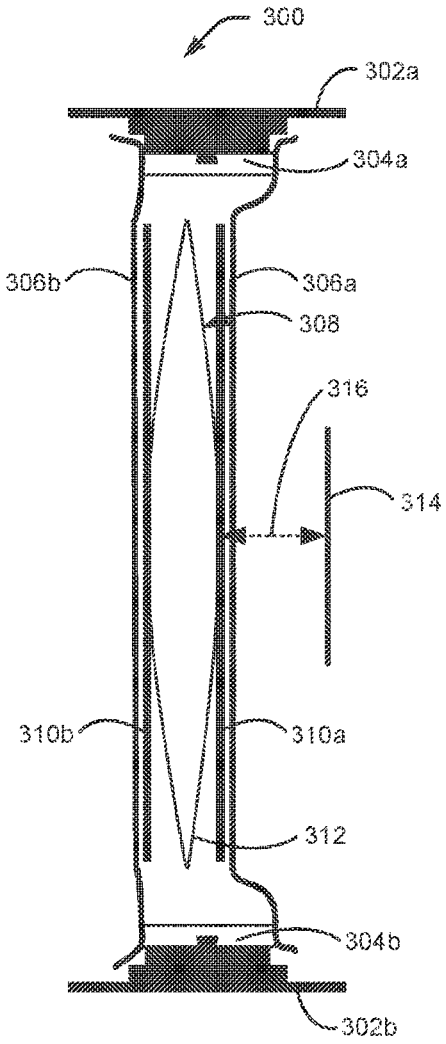
300
302a
304a
306b
306a
308
316
314
310b
310a
312
304b
302b

Fig. 3B

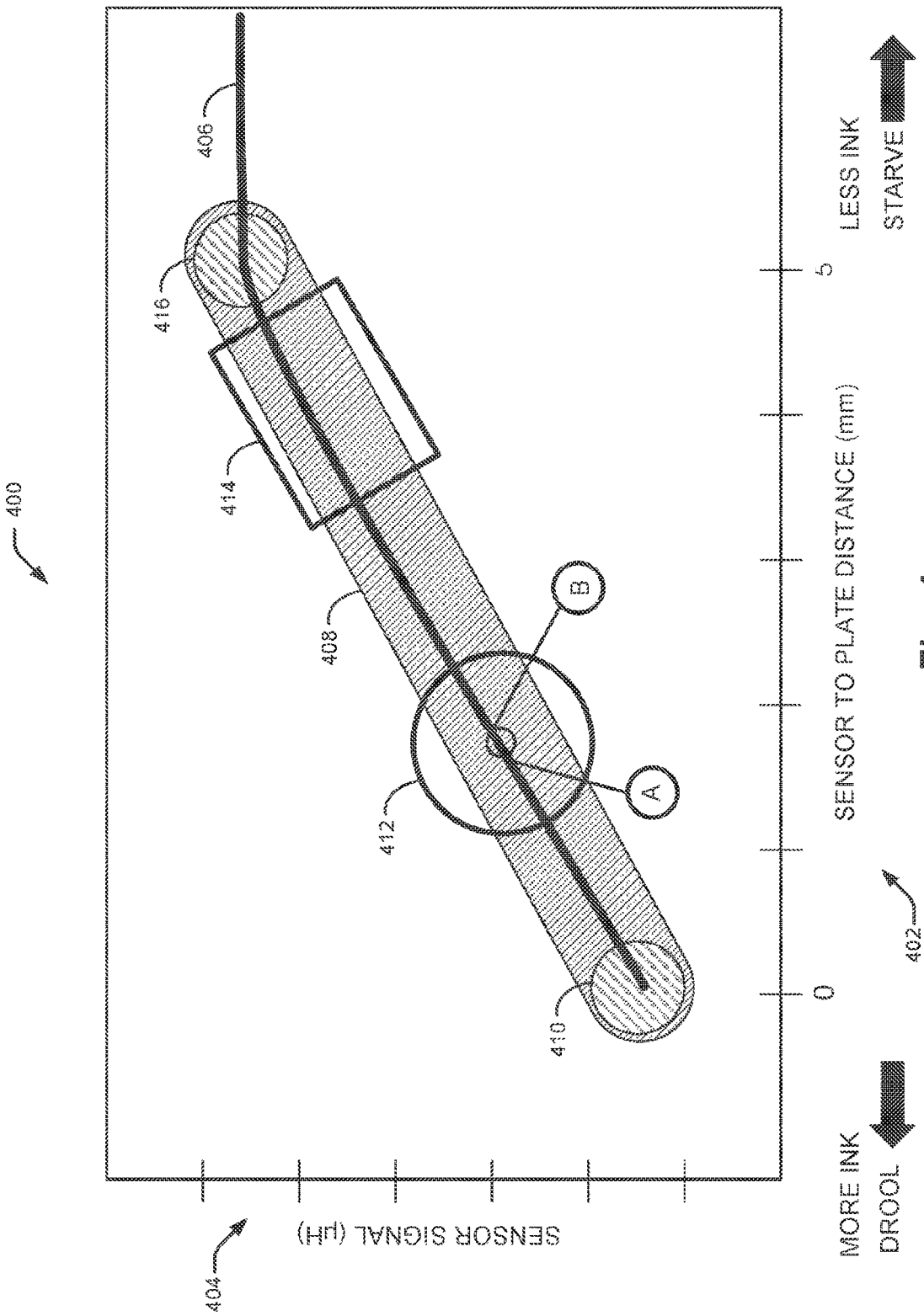
400
406
416
414
408
412
410
A
B
C
404
SENSOR SIGNAL (μH)
402
0
5
SENSOR TO PLATE DISTANCE (mm)
MORE INK
DROOL
LESS INK
STARVE

Fig. 4

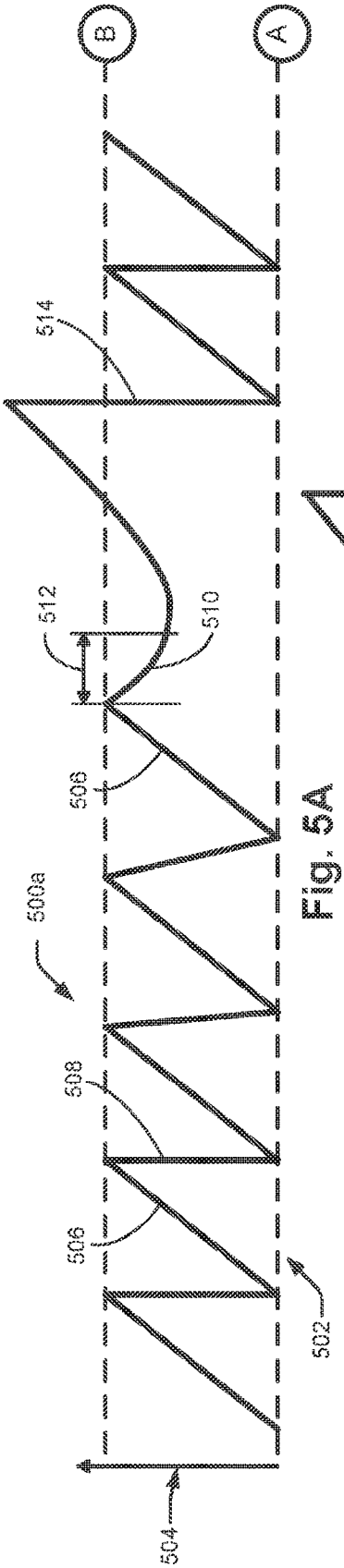

Fig. 5A

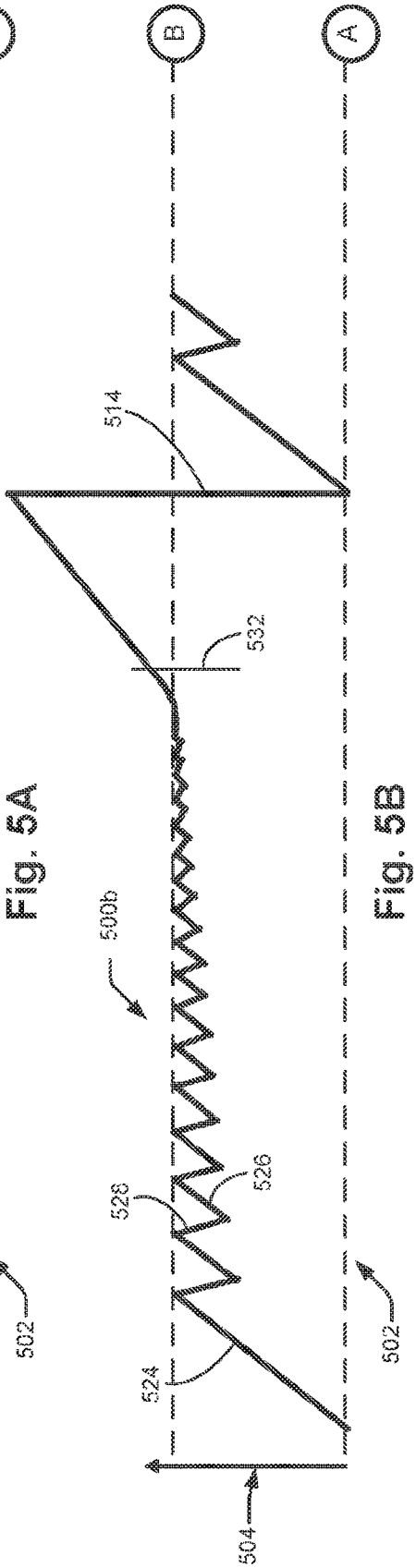

Fig. 5B

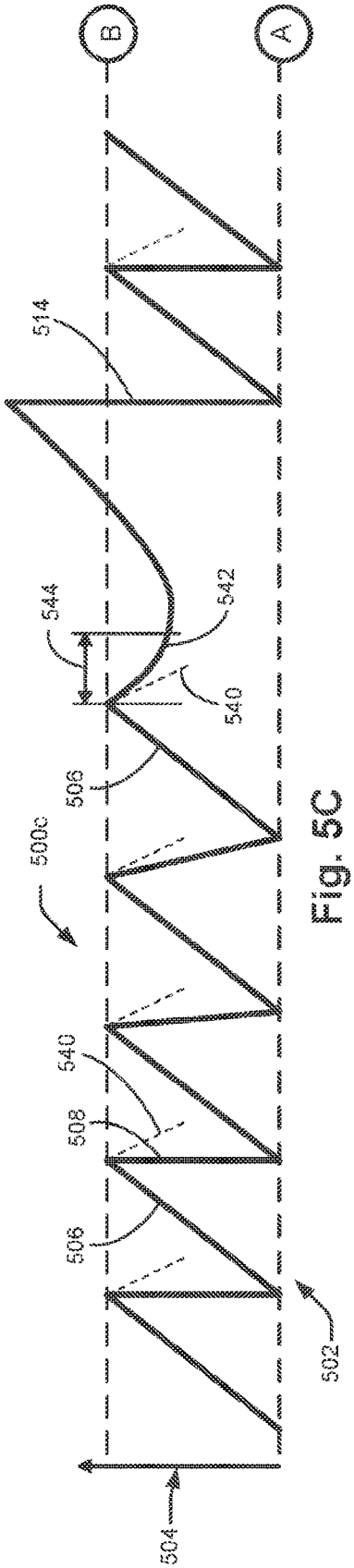

Fig. 5C

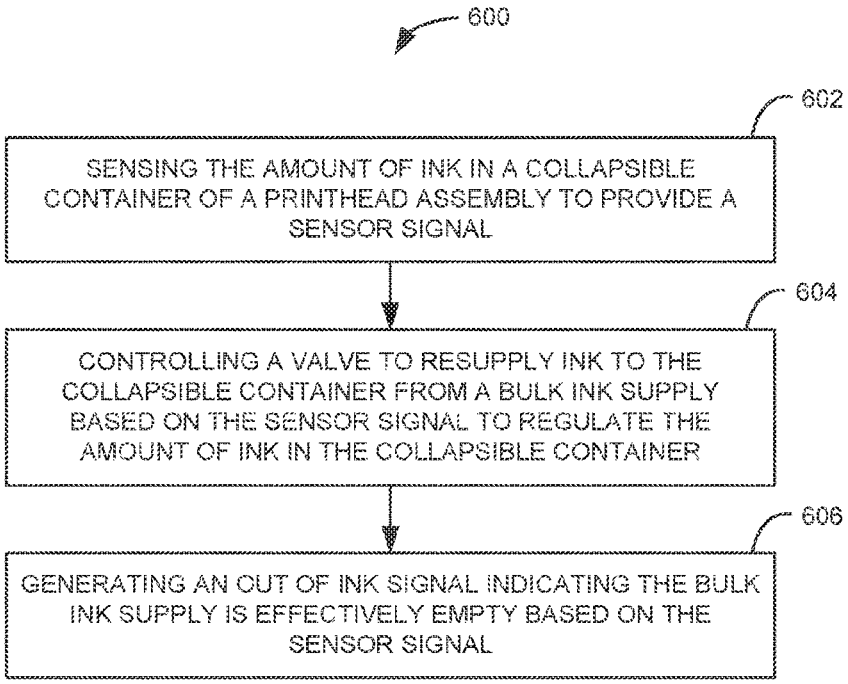
600
602
SENSING THE AMOUNT OF INK IN A COLLAPSIBLE CONTAINER OF A PRINTHEAD ASSEMBLY TO PROVIDE A SENSOR SIGNAL
604
CONTROLLING A VALVE TO RESUPPLY INK TO THE COLLAPSIBLE CONTAINER FROM A BULK INK SUPPLY BASED ON THE SENSOR SIGNAL TO REGULATE THE AMOUNT OF INK IN THE COLLAPSIBLE CONTAINER
606
GENERATING AN OUT OF INK SIGNAL INDICATING THE BULK INK SUPPLY IS EFFECTIVELY EMPTY BASED ON THE SENSOR SIGNAL

Fig. 6

PRINTHEAD ASSEMBLY

BACKGROUND

An inkjet printing system, as one example of a fluid ejection system, may include a printhead, an ink supply which supplies liquid ink to the printhead, and an electronic controller which controls the printhead. The printhead, as one example of a fluid ejection device, ejects drops of ink through a plurality of nozzles or orifices and toward a print medium, such as a sheet of paper, so as to print onto the print medium. In some examples, the orifices are arranged in at least one column or array such that properly sequenced ejection of ink from the orifices causes characters or other images to be printed upon the print medium as the printhead and the print medium are moved relative to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating one example of an inkjet printing system.

FIG. **2** is a block diagram illustrating one example of an ink regulation and out of ink signal generation system.

FIG. **3**A illustrates one example of a collapsible container in an expanded state and FIG. **3**B illustrates one example the collapsible container in a collapsed state.

FIG. **4** is a chart illustrating one example of a sensor signal.

FIGS. **5**A-**5**C are charts illustrating example sensor signals for example regulation and out of ink signal generation processes.

FIG. **6** is a flow diagram illustrating one example of a method for regulating ink and providing an out of ink signal.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific examples in which the disclosure may be practiced. It is to be understood that other examples may be utilized and structural or logical changes may be made without departing from the scope of the present disclosure. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims. It is to be understood that features of the various examples described herein may be combined, in part or whole, with each other, unless specifically noted otherwise.

FIG. **1** is a block diagram illustrating one example of an inkjet printing system **100**. Inkjet printing system **100** includes a fluid ejection assembly, such as printhead assembly **102**, and a fluid supply assembly, such as bulk ink assembly **110**. In the illustrated example, inkjet printing system **100** also includes a valve **114**, a carriage assembly **116**, a print media transport assembly **118**, and an electronic controller **120**. While the following description provides examples of systems and assemblies for fluid handling with regard to ink, the disclosed systems and assemblies are also applicable to the handling of fluids other than ink, including other liquids and/or toners and 3D powders.

Printhead assembly **102** includes at least one printhead or fluid ejection device which ejects drops of ink or fluid through a plurality of orifices or nozzles **108**. In one example, the drops are directed toward a medium, such as print media **124**, so as to print onto print media **124**. Print medium **124** includes any type of suitable sheet material,

such as paper, card stock, transparencies, Mylar, fabric, and the like. In one example, nozzles **108** are arranged in at least one column or array such that properly sequenced ejection of ink from nozzles **108** causes characters, symbols, and/or other graphics or images to be printed upon print media **124** as printhead assembly **102** and print media **124** are moved relative to each other. Printhead assembly **102** also includes a sensor **104** and a collapsible container **106**. Collapsible container **106** supplies ink to nozzles **108**. Sensor **104** senses the amount of ink within collapsible container **106**. In one example, printhead assembly **102** including sensor **104**, collapsible container **106**, and nozzles **108** are housed together in an inkjet or fluid-jet print cartridge or pen.

Bulk ink assembly **110** supplies ink to collapsible container **106** of printhead assembly **102** and includes a bulk ink supply **112** for storing ink. Bulk ink assembly **110** is separate from printhead assembly **102** and supplies ink to printhead assembly **102** through a first interface connection **113**, such as a supply tube, valve **114**, and a second interface connection **115**, such as another supply tube.

Carriage assembly **116** positions printhead assembly **102** relative to print media transport assembly **118** and print media transport assembly **118** positions print media **124** relative to printhead assembly **102**. Thus, a print zone **126** is defined adjacent to nozzles **108** in an area between printhead assembly **102** and print media **124**. In one example, printhead assembly **102** is a scanning type printhead assembly such that carriage assembly **116** moves printhead assembly **102** relative to print media transport assembly **118**. In another example, printhead assembly **102** is a non-scanning type printhead assembly such that carriage assembly **116** fixes printhead assembly **102** at a prescribed position relative to print media transport assembly **124**.

Electronic controller **120** communicates with printhead assembly **102** through a communication path **103**, carriage assembly **116** through a communication path **117**, print media transport assembly **118** through a communication path **119**, and valve **114** through a communication path **123**. In one example, when printhead assembly **102** is mounted in carriage assembly **116**, electronic controller **120** and printhead assembly **102** may communicate via carriage assembly **116** through a communication path **101**. Electronic controller **120** may also communicate with bulk ink assembly **110** such that, in one implementation, a new (or used) ink supply may be detected.

Electronic controller **120** receives data **128** from a host system, such as a computer, and may include memory for temporarily storing data **128**. Data **128** may be sent to inkjet printing system **100** along an electronic, infrared, optical or other information transfer path. Data **128** represent, for example, a document and/or file to be printed. As such, data **128** form a print job for inkjet printing system **100** and includes at least one print job command and/or command parameter.

In one example, electronic controller **120** provides control of printhead assembly **102** including timing control for ejection of ink drops from nozzles **108**. As such electronic controller **120** defines a pattern of ejected ink drops which form characters, symbols, and/or other graphics or images on print media **124**. Timing control and, therefore, the pattern of ejected ink drops, is determined by the print job commands and/or command parameters. In one example, logic and drive circuitry forming a portion of electronic controller **120** is located on printhead assembly **102**. In another example, logic and drive circuitry forming a portion of electronic controller **120** is located off printhead assembly **102**.

Electronic controller **120** includes an ink regulation module **122**. Ink regulation module **122** receives the sensor signal from sensor **104** of printhead assembly **102**. Ink regulation module **122** regulates the amount of ink within collapsible container **106** and provides an out of ink signal based on the sensor signal. Based on the sensor signal, ink regulation module **122** provides a control signal to valve **114** to open and/or close valve **114** to selectively transfer ink from bulk ink supply **112** to collapsible container **106** to regulate the amount of ink within collapsible container **106**.

When bulk ink supply **112** is effectively empty (i.e., for a given ink extraction process the ink flow rate slows greatly, e.g., less than 20% of the full flow rate), the refill rate of collapsible container **106** when valve **114** is open will decrease. This decrease in the refill rate of collapsible container **106** is detected by ink regulation module **122** based on the sensor signal. In response to detecting a decrease in the refill rate, ink regulation module **122** generates an out of ink signal indicating bulk ink supply **112** is effectively empty. In response to the out of ink signal, a user of inkjet printing system **100** may be prompted to replace or refill bulk ink supply **112**. Printhead assembly **102** may continue printing after the out of ink signal is generated until the sensor signal indicates that collapsible container **106** is also effectively empty.

FIG. **2** is a block diagram illustrating one example of an ink regulation and out of ink signal generation system **200**. System **200** includes a printhead assembly **202**, a bulk ink assembly **210**, a solenoid valve **214**, a controller **220**, and a manifold **230**. Printhead assembly **202** includes a sensor **204**, a collapsible container **206**, and nozzles **208**. Collapsible container **206** supplies ink to nozzles **208**. Sensor **204** senses the amount of ink within collapsible container **206**. In one example, printhead assembly **202** including sensor **204**, collapsible container **206**, and nozzles **208** are housed together in an inkjet or fluid-jet print cartridge or pen.

Bulk ink assembly **210** supplies ink to collapsible container **206** of printhead assembly **202** and includes a bulk ink supply **212** for storing ink. Bulk ink assembly **210** is separate from printhead assembly **202** and supplies ink to printhead assembly **202** through a first interface connection **213**, solenoid valve **214**, a second interface connection **238**, manifold **230**, and a third interface connection **215**. Interface connections **213**, **238**, and **215** may be supply tubes. Manifold **230** includes an input port **232** connected to second interface connection **238**, a first output port **234** connected to third interface connection **215**, and a plurality of other output ports **236**, which may supply ink to other printhead assemblies (not shown) from bulk ink assembly **210**. In one example, bulk ink supply **212** may be pressurized (e.g., 4-6 PSI) by air received through an interface connection **211** to force ink into collapsible container **206** when solenoid valve **214** is open. In other examples, ink from bulk ink supply **212** may be gravity fed into collapsible container **206** when solenoid valve **214** is open.

Controller **220** receives a sensor signal from sensor **204** through a communication path **203** and provides a control signal to solenoid valve **214** through a communication path **223**. In one example, controller **220** is a separate controller from an electronic controller used to control the other functions of a printing system in which printhead assembly **202** is installed. Controller **220** regulates the amount of ink within collapsible container **206** and provides an out of ink signal based on the sensor signal. Based on the sensor signal, controller **220** provides a control signal to solenoid valve **214** to open and/or close valve **214** to selectively transfer ink from bulk ink supply **212** to collapsible container **206** to regulate the amount of ink within collapsible container **206**.

When bulk ink supply **212** is effectively empty (i.e., for a given ink extraction process the ink flow rate slows greatly, e.g., less than 20% of the full flow rate), the refill rate of collapsible container **206** when solenoid valve **214** is open will decrease. This decrease in the refill rate of collapsible container **206** is detected by controller **220** based on the sensor signal. In response to detecting a decrease in the refill rate, controller **220** generates an out of ink signal indicating bulk ink supply **212** is effectively empty. In response to the out of ink signal, a user of system **200** may be prompted to replace or refill bulk ink supply **212**. Printhead assembly **202** may continue printing after the cut of ink signal is generated until the sensor signal indicates that collapsible container **206** is also effectively empty.

FIG. **3**A illustrates one example of a collapsible container **300** in an expanded state and FIG. **3**B illustrates one example of collapsible container **300** in a collapsed state. Collapsible container **300** may provide collapsible container **206** previously described and illustrated with reference to FIG. **2**. In one example, collapsible container **300** is a spring bag. Collapsible container **300** includes a top housing portion **302***a*, a bottom housing portion **302***b*, a first flexible sidewall **306***a*, a second flexible sidewall **306***b*, and a spring assembly **308** between the first flexible sidewall **306***a* and the second flexible sidewall **306***b*. Spring assembly **308** includes a first plate **310***a* coupled to a second plate **310***b* via a leaf spring **312**.

The top side of each flexible sidewall **306***a* and **306***b* is attached to top housing portion **302***a* via a connector **304***a*. The bottom side of each flexible sidewall **306***a* and **306***b* is attached to bottom housing portion **302***b* via a connector **304***b*. Flexible sidewalls **306***a* and **306***b* may comprise biaxially-oriented polyethylene terephthalate (BoPET) or another suitable material. Spring assembly **308** exerts constant pressure against flexible sidewalls **306***a* and **306***b* to expand. When ink is removed from collapsible container **300**, flexible sidewalls **306***a* and **306***b* squeeze together as illustrated in FIG. **3**B. When ink is added to collapsible container **300**, flexible sidewalls **306***a* and **306***b* move further apart as illustrated in FIG. **3**A. Spring assembly **308** maintains a sufficient back pressure within collapsible container **300** for proper ejection of ink from the nozzles of the printhead assembly.

In one example, second flexible sidewall **306***b* is constrained to limit the movement of second flexible sidewall **306***b* and first flexible sidewall **306***a* is not constrained. Second flexible sidewall **306***b* may be constrained by attaching second flexible sidewall **306***b* between top housing portion **302***a* and bottom housing portion **302***b* tightly such that second flexible sidewall **306***b* includes little or no excess material between top housing portion **302***a* and bottom housing portion **302***b*. First flexible sidewall **306***a* may be attached between top housing portion **302***a* and bottom housing portion **302***b* loosely such that first flexible sidewall **306***a* includes excess material between top housing portion **302***a* and bottom housing portion **302***b*. Accordingly, first flexible sidewall **306***a* moves to a much greater extent than second flexible sidewall **306***b* when ink is added and/or removed from collapsible container **300**.

A sensor **314** attached to a sidewall of the housing (not shown) is arranged to sense the position of first plate **310***a* of spring assembly **308** relative to sensor **314**. Sensor **314** provides a signal indicating the distance **316** (FIG. **3**B) between sensor **314** and first plate **310***a*. In one example, sensor **314** may include a resonant circuit including an

inductive coil for sensing the position of first plate **310***a* relative to sensor **314**. In other examples, sensor **314** may include other suitable components for sensing the distance between first plate **310***a* and sensor **314**. The sensor signal may be received by a controller, such as controller **220** previously described and illustrated with reference to FIG. **2**, to determine the amount of ink within collapsible container **300**, to regulate the amount of ink supplied to collapsible container **300** from a bulk ink supply, and to determine when the bulk ink supply is effectively empty.

FIG. **4** is a chart **400** illustrating one example of a sensor signal **406**. Sensor signal **406** may be received from sensor **314** previously described and illustrated with reference to FIGS. **3**A and **3**B. Chart **400** includes the sensor to plate distance in millimeters (mm) on x-axis **402** and the sensor signal in microHenry (μH) on y-axis **404**. The amount of ink within the collapsible container may be determined by sensor signal **406** and is indicated at **408**. While chart **400** illustrates a sensor to plate distance having a range between 0 mm and 5 mm, in other examples, the range of the sensor to plate distance may vary depending on the dimensions of the collapsible container and the position of the sensor relative to the collapsible container.

For a sensor to plate distance of about 0 mm as indicated at **410**, the collapsible container is full. Excess pressure or ink within the collapsible container may result in ink drool through the nozzles of the printhead assembly. For a sensor to plate distance of about 5 mm as indicated at **416**, the collapsible container is effectively empty and the nozzles of the printhead assembly may be starved for ink. An ink fill target is indicated at **414** for a sensor to a plate distance between about 4 mm and 5 mm. The ink fill target may be the amount of ink within a collapsible container prior to use within a printing system (e.g., for shipping).

In this example, a regulation zone is indicated at **412** at a sensor to plate distance of around 2 mm. The regulation zone defines ink volume thresholds between which the controller should maintain the volume of ink within the collapsible container by periodically refilling the collapsible container from a bulk ink supply. A first threshold (i.e., a shorter sensor to plate distance) is indicated at (A) and a second threshold (i.e., a longer sensor to plate distance than the first threshold) is indicated at (B). In one example, the difference in the volume of ink within the collapsible container between threshold (A) and threshold (B) is approximately 0.6 milliliters.

FIGS. **5**A-**5**C are charts illustrating example sensor signals for example regulation and out of ink signal generation processes. FIG. **5**A is a chart **500***a* illustrating bang-bang regulation. Chart **500***a* includes time on x-axis **502** and the sensor signal on y-axis **504**. In bang-bang regulation, the controller maintains the amount of ink within the collapsible container between thresholds (A) and (B). As the printhead assembly ejects ink, the sensor signal moves from threshold (A) to threshold (B) as indicated at **506**. Once the sensor signal reaches threshold (B) or crosses threshold (B), the controller provides the control signal to open the valve to refill the collapsible container as indicated at **508**. Once the sensor signal reaches threshold (A) or crosses threshold (A), the controller provides the control signal to close the valve to stop the refill of the collapsible container.

As the bulk ink supply empties, the refill time to refill the collapsible container increases. Accordingly, as indicated at **510**. Once the bulk ink supply is effectively empty, the refill time will exceed a selected period indicated at **512** and the volume of ink within the collapsible container will not reach threshold (A) or cross threshold (A) within the selected period. The selected period may be a predetermined period (e.g., 10 seconds) or may be determined by the controller. For example, the controller may monitor the refill time at **508** and set the selected period to be greater than the monitored refill time. Once threshold (A) is not reached or crossed within the selected period from opening of the valve, the controller provides the out of ink signal indicating the bulk ink supply is effectively empty. When the out of ink signal is provided, the controller also closes the valve until the bulk ink supply is replenished. Once the bulk ink supply is replenished, the controller opens the valve to refill the collapsible container as indicated at **514** and the ink regulation resumes.

FIG. **5**B is a chart **500***b* illustrating pulse regulation. Chart **500***b* includes time on x-axis **502** and the sensor signal on y-axis **504**. In pulse regulation, the controller maintains the amount of ink within the collapsible container between thresholds (A) and (B). As the printhead assembly ejects ink, the sensor signal moves from threshold (A) to threshold (B) as indicated at **524**. Each time the sensor signal reaches threshold (B) or crosses threshold (B) or is above threshold (B), the controller provides the control signal to open the valve to refill the collapsible container as indicated at **528**. Once a selected period elapses, the valve is closed to stop the refill of the collapsible container. As the printhead assembly continues to eject ink, the sensor signal moves toward threshold (B) as indicated at **526**. The selected period may be a predetermined period (e.g., 100 milliseconds) or may be determined by the controller. For example, the controller may monitor the refill time at **528** and set the selected period to maintain the regulation between thresholds (A) and (B).

As the bulk ink supply empties, the refill time to refill the collapsible container increases. Accordingly, as indicated at **532**, once the bulk ink supply is effectively empty, the refill time will exceed the selected period and the volume of ink within the collapsible container will not cross threshold (B) toward threshold (A) within the selected period from the opening of the valve. In one example, once threshold (B) is not crossed within the selected period from opening of the valve, the controller provides the out of ink signal indicating the bulk ink supply is effectively empty. In another example, the controller provides the out of ink signal in response to the sensor signal not crossing threshold (B) within a selected number of valve open and close cycles (e.g., 3 cycles). In another example, the controller provides the out ink signal in response to the refill rate failing below a selected refill rate. When the cut of ink signal is provided, the controller leaves the valve closed until the bulk ink supply is replenished. Once the bulk ink supply is replenished, the controller opens the valve to refill the collapsible container as indicated at **514** and the ink regulation resumes.

FIG. **5**C is a chart **500***c* illustrating refill rate regulation. Chart **500***c* includes time on x-axis **502** and the sensor signal on y-axis **504**. In refill rate regulation, the controller maintains the amount of ink within the collapsible container between thresholds (A) and (B). As the printhead assembly ejects ink, the sensor signal moves from threshold (A) to threshold (B) as indicated at **506**. Once the sensor signal reaches threshold (B) or crosses threshold (B), the controller provides the control signal to open the valve to refill the collapsible container as indicated at **508**. Once the sensor signal reaches threshold (A) or crosses threshold (A), the controller provides the control signal to close the valve to stop the refill of the collapsible container.

As the bulk ink supply empties, the refill time to refill the collapsible container increases. Accordingly, as indicated at **542**, once the bulk ink supply is effectively empty, the refill

rate will fall below a selected refill rate as indicated at **540**. The selected refill rate may be a predetermined rate or may be determined by the controller. For example, the controller may monitor the refill rate at **508** and set the selected refill rate to be less than the monitored refill rate. The refill rate may be determined over a selected period indicated at **544**. The selected period may be a predetermined period (e.g., 10 seconds) or may be determined by the controller. For example, the controller may monitor the refill time at **508** and set the selected period to be greater than the monitored refill time. Once the sensed refill rate falls below the selected refill rate, the controller provides the out of ink signal indicating the bulk ink supply is effectively empty. When the out of ink signal is provided, the controller also closes the valve until the bulk ink supply is replenished. Once the bulk ink supply is replenished, the controller opens the valve to refill the collapsible container as indicated at **514** and the ink regulation resumes.

FIG. **6** is a flow diagram illustrating one example of a method **600** for regulating ink and providing an out of ink signal. At **602**, the method includes sensing the amount of ink in a collapsible container of a printhead assembly to provide a sensor signal. In one example, sensing the amount of ink in the collapsible container comprises inductively sensing the distance between a plate of the collapsible container and a sidewall of the printhead assembly. At **604**, the method includes controlling a valve to resupply ink to the collapsible container from a bulk ink supply based on the sensor signal to regulate the amount of ink in the collapsible container. At **606**, the method includes generating an out of ink signal indicating the bulk ink supply is effectively empty based on the sensor signal.

In one example, controlling the valve comprises opening the valve in response to the sensor signal reaching a first threshold and closing the valve in response to the sensor signal reaching a second threshold. Generating the out of ink signal may comprise generating the out of ink signal in response to the sensor signal failing to reach the second threshold within a selected period from the opening of the valve. In another example, generating the out of ink signal may comprise generating the out of ink signal in response to an ink resupply rate falling below a selected rate.

In another example, controlling the valve comprises opening the valve in response to the sensor signal crossing a threshold from a first side to a second side of the threshold and closing the valve in response to a selected period elapsing from the opening of the valve. Generating the out of ink signal may comprise generating the out of ink signal in response to the sensor signal remaining on the second side of the threshold after the selected period elapses. In another example, generating the out of ink signal may comprise generating the out of ink signal in response to the sensor signal remaining on the second side of the threshold for a selected number of valve open and close cycles.

Although specific examples have been illustrated and described herein, a variety of alternate and/or equivalent implementations may be substituted for the specific examples shown and described without departing from the scope of the present disclosure. This application is intended to cover any adaptations or variations of the specific examples discussed herein. Therefore, it is intended that this disclosure be limited only by the claims and the equivalents thereof.

The invention claimed is:

1. A system comprising:

a bulk ink assembly to receive a bulk ink supply;

a printhead assembly including nozzles to eject ink drops, a collapsible container to supply ink to the nozzles, and a sensor to provide a sensor signal indicating an amount of ink within the collapsible container;

a valve to supply ink to the collapsible container from the bulk ink assembly in response to a control signal; and

a controller to provide the control signal based on the sensor signal, to regulate the amount of ink in the collapsible container, and to provide an out of ink signal based on the sensor signal indicating the bulk ink supply is effectively empty.

2. The system of claim **1**, wherein the controller is to provide the control signal and the out of ink signal in response to the sensor signal provided from the sensor, the sensor is to sense the amount of ink within the collapsible container, and the controller is further to:

provide the control signal to open the valve in response to the sensor signal reaching a first threshold and to close the valve in response to the sensor signal reaching a second threshold to regulate the amount of ink in the collapsible container, and

provide the out of ink signal in response to the sensor signal not reaching the second threshold within a selected period from reaching the first threshold.

3. The system of claim **1**, wherein the controller provides the control signal to open the valve in response to the sensor signal reaching a first threshold to resupply ink to the collapsible container and to close the valve in response to the sensor signal reaching a second threshold, and

wherein the controller provides the out of ink signal in response to an ink resupply rate falling below a selected rate.

4. The system of claim **1**, wherein the controller provides the control signal to open the valve in response to the sensor signal crossing a threshold from a first side to a second side of the threshold and to close the valve in response to a selected period elapsing from the opening of the valve, and

wherein the controller provides the out of ink signal in response to the sensor signal not crossing the threshold from the second side to the first side within the selected period.

5. The system of claim **1**, wherein the controller provides the control signal to open the valve in response to the sensor signal being on a first side of a threshold and to close the valve in response to a selected period elapsing from the opening of the valve, and

wherein the controller provides the out of ink signal in response to the sensor signal not crossing from the first side of the threshold to a second side of the threshold within a selected number of valve open and close cycles.

6. The system of claim **1**, wherein the printhead assembly is one of a plurality of printhead assemblies including nozzles to eject ink drops, and further comprising:

a manifold between the bulk ink assembly and the valve, the manifold to supply ink from the bulk ink assembly to the plurality of printhead assemblies.

7. The system of claim **1**, wherein the bulk ink assembly includes a container with bulk ink, the controller includes circuitry to provide the control signal in response to the sensor signal provided by the sensor, and the valve is to supply ink to the collapsible container in response to the control signal from the controller.

8. The system of claim **1**, wherein the collapsible container includes a top housing portion, a bottom housing portion, a first flexible sidewall and a second flexible sidewall and a spring assembly between the first flexible side-

wall and the second flexible sidewall to exert force against the first flexible sidewall and the second flexible sidewall.

9. The system of claim **1**, wherein the controller is to provide the control signal to open the valve in response to the sensor signal reaching a first threshold and to close the valve in response to the sensor signal reaching a second threshold to maintain an ink fill target within the collapsible container, and

wherein the controller is to provide the out of ink signal in response to the sensor signal reaching the second threshold outside a selected period from reaching the first threshold.

10. The system of claim **1**, wherein the controller is to provide the out of ink signal in response to the sensor signal indicating an ink fill target is unreached within a selected period of time, and in response to the out of ink signal, the print assembly including the nozzles is to continue to eject ink drops until the sensor signal indicates the collapsible container is effectively empty.

11. The system of claim **1**, wherein the controller is to provide the control signal and the out of ink signal in response to the sensor signal provided from the sensor, the sensor is to sense the amount of ink within the collapsible container.

12. A printhead assembly comprising:

nozzles to eject ink drops;

a collapsible container to supply ink to the nozzles; and

a sensor to provide a sensor signal indicating an amount of ink sensed within the collapsible container,

wherein the sensor signal is to provide to an electronic controller that controls resupply of ink to the collapsible container from a bulk ink supply in response to the sensor signal provided from the sensor to regulate the amount of ink in the collapsible container and, the electronic controller is provide an out of ink signal indicating the bulk ink supply is effectively empty in response to the sensor signal provided from the sensor indicating an ink resupply time above a threshold.

13. The printhead assembly of claim **12**, wherein the collapsible container comprises a spring bag, and

wherein the sensor comprises an inductive coil to sense a position of a plate of the spring bag relative to the inductive coil of the collapsible container.

14. The printhead assembly of claim **13**, wherein motion of a first sidewall of the spring bag is constrained and motion of a second sidewall of the spring bag opposite to the first sidewall is not constrained.

15. The printhead assembly of claim **12**, wherein the controller controls the resupply of ink to the collapsible container via a solenoid valve connected between the collapsible container and the bulk ink supply, and the signal sensor that causes the control signal and the out of ink signal is from the same sensor.

16. A method comprising:

sensing an amount of ink in a collapsible container of a printhead assembly that includes nozzles to eject ink drops and a sensor to provide a sensor signal indicative of the amount of ink sensed in the collapsible container;

to regulate the amount of ink in the collapsible container, controlling a valve to resupply ink to the collapsible container from a bulk ink supply in response to the sensor signal provided from the sensor; and

generating an out of ink signal for the bulk ink supply in response to the sensor signal provided from the sensor.

17. The method of claim **16**, wherein controlling the valve comprises opening the valve in response to the sensor signal reaching a first threshold and closing the valve in response to the sensor signal reaching a second threshold, and

wherein generating the out of ink signal comprises generating the out of ink signal in response to the sensor signal failing to reach the second threshold within a selected period from the opening of the valve.

18. The method of claim **16**, wherein controlling the valve comprises opening the valve in response to the sensor signal reaching a first threshold and closing the valve in response to the sensor signal reaching a second threshold, and

wherein generating the out of ink signal comprises determining an ink resupply rate based on the sensor signal provided from the sensor, and generating the out of ink signal in response to the ink resupply rate falling below a selected rate.

19. The method of claim **16**, wherein controlling the valve comprises opening the valve in response to the sensor signal crossing a threshold from a first side to a second side of the threshold and closing the valve in response to a selected period elapsing from the opening of the valve, and

wherein generating the out of ink signal comprises generating the out of ink signal in response to the sensor signal remaining on the second side of the threshold after the selected period elapses.

20. The method of claim **16**, wherein sensing the amount of ink in the collapsible container comprises inductively sensing a distance between a plate of the collapsible container and a sidewall of the printhead assembly by the sensor.

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